Speciation Lab

Purpose: This lab will reinforce the concepts of speciation and also use the data provided to construct a practice lab report.

Imagine that you are an evolutionary biologist interested in studying the topic of speciation in a pair of organisms. You research the following background information about your two groups:

Smooth Sunflower: The typical range is along the southeastern US and its most frequent pollinator is the Maple Mining Bee. Reproduction relies on the bees and the timeframes for flowering are shown along with some other reproductive features. The egg cells produced in the ovary have specific chemical receptors on them that will only allow fertilization by contact with the sperm of the population types listed. The style/stigma is a large tube through which a pollen grain will form a small pollen tube, which elongates by cell division to a certain length, specified in table 1.

Maple Mining Bee: The typical range is along the southeastern US with each population's typical nest sites indicated. The egg cells produced in the ovary have specific chemical receptors on them that will only allow fertilization by contact with the sperm of the population types listed. Mating rituals have developed in which a very specific dance is performed by males & females to determine their readiness to breed, taking place during the breeding range as indicated in table 2.

Samples of bees & sunflowers were collected from each population site and brought to a controlled facility. A number of crosses between members of the different populations were performed and you recorded the percentage of viable offspring produced from each cross, shown in tables 3 & 4. Some other specific methods are listed below.

- Sunflowers & bees of each population type were combined in the facility for a period of 1 year.
- Female sperm receptor types were determined by removing sperm & egg samples from random members of each population. Sperm samples were then mixed with egg samples in vitro. If the egg receptor was activated, an injected dye would fluoresce green from a reaction between sperm proteins & egg receptors.
- Sunflower stigmas/styles were measured by randomly sampling population members and dissecting them; a microscope equipped with a ruler was used to determine structure lengths.
- Pollen tube length was measured by randomly selecting samples to artificially add pollen grains to; the samples were placed into a digital microscope chamber where video footage was recorded. Maximum tube length was determined when the formed pollen tube just began to dissolve.
- Bee waggle dance turn distance was determined by recording random intervals throughout the year and measuring the distance using the embedded software.
- All members of original populations were identified with tags showing their population location.

Table 1: Smooth Sunflower *Helianthus laevigatus* Features

	Population A	Population B	Population C	Population D
Flowering Timeframe	Early Spring	Early Spring	Early Summer	Early Spring
Habitat	Georgia, Swamps	Georgia, Fields	Virginia, Fields	Virginia, Fields
Female's Sperm Receptor Type	A	A, B	A, C	A, B, D
Style/Stigma Length	19mm	22mm	18mm	22mm
Maximum Pollen Tube Length	20mm	24mm	20mm	24mm

Table 2: Maple Mining Bee *Andrena fenningeri* Features

	Population A	Population B	Population C	Population D
Habitat/Nest Site	Georgia, Tree Tops	Georgia, Tree Tops	Virginia, Low Trunks	Virginia, Low Trunks
Females' Sperm Receptor Type	A	A, B, D	C	C, D
Waggle Dance Turn Distance	7mm	19mm	18mm	18mm
Breeding Timeframe	Early spring	Early Spring	Early Summer	Early Spring

In this study, you wish to address two questions for EACH species (bees/sunflowers):

Are the 4 populations distinct species?

Is there a difference between any observed isolating mechanisms?

Review tables 1 & 2 about the species' background information, review tables 3 & 4 to view experimental data for each species, and answer the prompts along the way.

Table 3: Offspring Viability Percent among Crosses of Sunflower Populations. Viability was determined based on seed ability to germinate. Values shown as 1x SE of the mean percentage seeds germinated.

		Males			
		A	B	C	D
Females	A	89% ± 2	0%	0%	0%
	B	27% ± 6	91% ± 4	0%	0%
	C	44% ± 1	0%	90% ± 1	0%
	D	12% ± 2	90% ± 2	0%	86% ± 2

1. Fill in the table below with the likely isolating mechanism(s) based on tables 1 & 3.

		Males			
		A	B	C	D
Females	A		GAMETIC	TEMPORAL GAMETIC	GAMETIC
	B	MECHANICAL		GAMETIC MECHANICAL	GAMETIC
	C	TEMPORAL	GAMETIC TEMPORAL		GAMETIC
	D	MECHANICAL	HABITAT	GAMETIC MECHANICAL	

Table 4: Offspring Viability Percent among Crosses of Bee Populations. Viability was determined based on egg hatchings. Values shown as 1x SE of the mean percentage of eggs hatched.

		Males			
		A	B	C	D
Females	A	86% ± 3	0%	0%	0%
	B	40% ± 4	88% ± 6	0%	74% ± 6
	C	0%	0%	96% ± 2	0%
	D	0%	0%	71% ± 8	93% ± 1

2. Fill in the table below with the likely isolating mechanism(s) based on tables 2 & 4.

		Males			
		A	B	C	D
Females	A		GAMETIC BEHAVIORAL	GAMETIC BEHAVIORAL HABITAT	GAMETIC BEHAVIORAL HABITAT
	B	BEHAVIORAL		GAMETIC TEMPORAL HABITAT	HABITAT
	C	GAMETIC BEHAVIORAL HABITAT	GAMETIC TEMPORAL HABITAT		GAMETIC TEMPORAL
	D	GAMETIC BEHAVIORAL HABITAT	GAMETIC HABITAT	TEMPORAL	

3. Write null hypotheses that will address the purpose questions on p.2 for both species & write how you will statistically determine the answer.

Are the 4 sunflower populations distinct species?

Ho NO DIFF IN GERM. % BETWEEN SAME POP. CROSSES & DIFF. POP. CROSSES.

PLOT DATA, CHECK FOR ERROR BAR OVERLAP.

Are the 4 bee populations distinct species?

Ho NO DIFF IN HATCHING. % BETWEEN SAME POP. CROSSES & DIFF. POP. CROSSES.

PLOT DATA, CHECK FOR ERROR BAR OVERLAP.

Is there a difference between any observed isolating mechanisms for the sunflower populations?

Ho NO DIFF. IN GERM. % BETWEEN **DISTINCT** ISOLATING MECHANISMS.

PLOT DATA, CHECK FOR ERROR BAR OVERLAP.

Is there a difference between any observed isolating mechanisms for the bee populations?

Ho NO DIFF. IN HATCHING. % BETWEEN **DISTINCT** ISOLATING MECHANISMS.

PLOT DATA, CHECK FOR ERROR BAR OVERLAP.

4. Construct figures that will address the hypotheses. This lab will not use a t-test or chi-square test.

Figure 1: Offspring Viability among Sunflower Population "A" Crosses

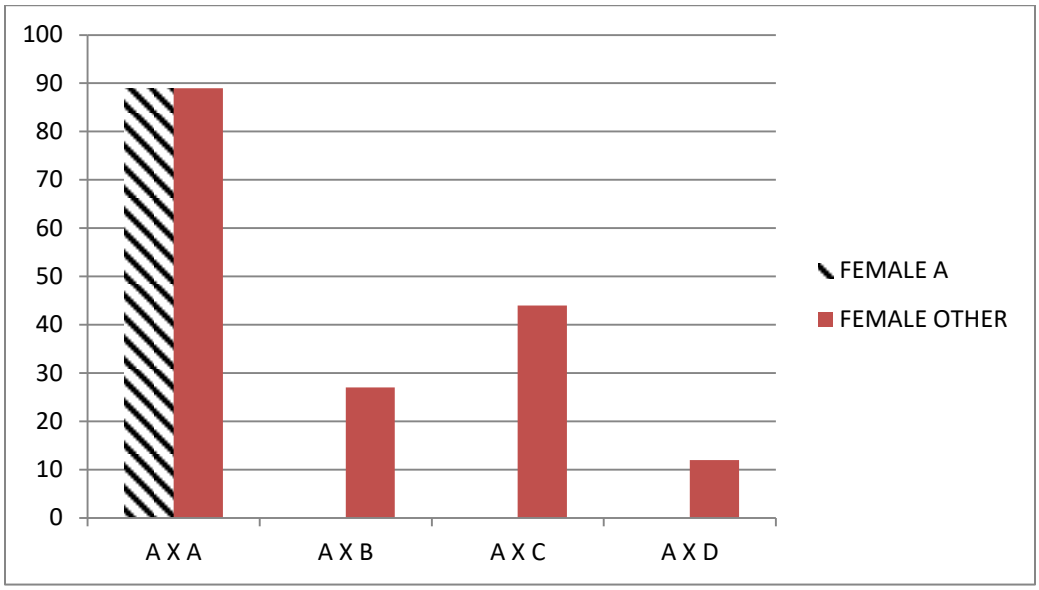

Figure 2: Offspring Viability among Sunflower Population "B" Crosses